Magnetic resonance imaging (MRI) and electroencephalography (EEG) are a promising means to an objectified assessment of cognitive impairment in Alzheimer's disease (AD). Individually, however, these modalities tend to lack precision in both AD diagnosis and AD staging. A joint MRI-EEG approach that combines structural with functional information has the potential to overcome these limitations. This cross-sectional study systematically investigated the link between MRI and EEG markers and the global cognitive status in early AD. We hypothesized that the joint modalities would identify cognitive deficits with higher accuracy than the individual modalities. In a cohort of 111 AD patients, we combined MRI measures of cortical thickness and regional brain volume with EEG measures of rhythmic activity, information processing and functional coupling in a generalized multiple regression model. Machine learning classification was used to evaluate the markers' utility in accurately separating the subjects according to their cognitive score. We found that joint measures of temporal volume, cortical thickness, and EEG slowing were well associated with the cognitive status and explained 38.2% of its variation. The inclusion of the covariates age, sex, and education considerably improved the model. The joint markers separated the subjects with an accuracy of 84.7%, which was considerably higher than by using individual modalities. These results suggest that including joint MRI-EEG markers may be beneficial in the diagnostic workup, thus allowing for adequate treatment. Further studies in larger populations, with a longitudinal design and validated against functional-metabolic imaging are warranted to confirm the results.